

Serial No.: 10/713,298
Art Unit: 1725***AMENDMENTS TO THE CLAIMS***

1. (Currently Amended) A laser machining apparatus comprising:
a laser beam configured to form a feature in a surface of a substrate;
a first liquid supply structure for directing liquid at the feature, wherein the feature ~~can comprise~~ comprises a shadow region to which liquid directed from the first liquid supply structure is obstructed; and,
at least a second different liquid supply structure for directing liquid generally toward the shadow region, wherein the first and second liquid supply structures are configured to deliver liquid to the feature at least a portion of a time that the laser beam operates on the substrate, wherein the feature is an elongate feature which extends generally along a long axis between a first feature end and a generally opposing second feature end, and wherein the first liquid supply structure is positioned proximate to the first feature end and the second liquid supply structure is positioned proximate to the second feature end.
2. (Original) The laser machining apparatus of claim 1, wherein the feature comprises a blind feature.
3. (Original) The laser machining apparatus of claim 1, wherein the feature comprises a through feature.
4. (Canceled)
5. (Currently Amended) The laser machining apparatus of claim [[4]] 1, wherein the first liquid supply structure is oriented to eject liquid along a first axis which lies at an acute angle relative to the long axis and the second liquid supply structure is oriented to eject liquid along a second axis which lies at a second different acute angle relative to the long axis.

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6. (Original) The laser machining apparatus of claim 5, wherein the first axis lies at a 50 degree angle relative to a first substrate surface into which the feature is formed and the second axis lies at a 50 degree angle to the first surface and 80 degrees relative to the first axis.

7. (Currently Amended) The laser machining apparatus of claim [[4]] 1, wherein the first liquid supply structure and the second liquid supply structure each terminate about 10 microns above a first substrate surface into which the feature is formed.

8. (Currently Amended) The laser machining apparatus of claim [[4]] 1, wherein the first liquid supply structure is positioned at least about 5 millimeters back from the first feature end and the second liquid supply structure is positioned at least about 5 millimeters back from the second feature end.

9. (Original) An apparatus comprising:

at least one laser source that supplies a laser beam to operate on a substrate at a laser interaction zone to form a feature in the substrate;

a first nozzle oriented to deliver liquid along a first liquid supply path to the feature, so that the liquid is delivered to the laser interaction zone; and,

at least a second different nozzle oriented to deliver liquid to the laser interaction zone along a second different liquid supply path, wherein the first nozzle and at least the second different nozzle are selectively activated based upon the location of the laser interaction zone in the substrate.

10. (Original) The apparatus of claim 9, wherein the first nozzle and the at least a second nozzle comprise a plurality of nozzles oriented to provide liquid in a pattern generally approximating a footprint of the feature.

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11. (Original) The apparatus of claim 9 further comprising a controller for selectively controlling a delivery of liquid from individual nozzles wherein the controller is configured to shut-off the flow of liquid from the first nozzle to allow the at least a second nozzle to deliver liquid to the laser interaction zone.

12. (Original) The laser machining apparatus of claim 9, wherein the feature is an elongate feature which extends generally along a long axis between a first feature end and a generally opposing second feature end, and wherein the first nozzle is positioned proximate to the first feature end and the second nozzle is positioned proximate to the second feature end.

13. (Original) The apparatus of claim 9, wherein the first nozzle and the at least a second nozzle are configured to deliver liquid in the form of an atomized mist.

14. (Original) The laser machining apparatus of claim 9, wherein the first liquid supply path lies at a 50 degree angle relative to a first substrate surface into which the feature is formed and the second axis lies at a 50 degree angle to the first surface and 80 degrees relative to the second liquid supply path.

15. (Original) The laser machining apparatus of claim 14, wherein the first nozzle and the second nozzle each terminate about 10 microns above the first substrate surface into which the feature is formed.

16. (Original) The laser machining apparatus of claim 14, wherein the first nozzle is positioned at least about 5 millimeters back from the first feature end and the second nozzle is positioned at least about 5 millimeters from a second feature end.

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17. (Currently Amended) An apparatus comprising:
a laser beam configured to act on a substrate to form a feature through a first substrate surface; and,
a first nozzle oriented to deliver liquid to the feature and at least a second nozzle oriented to deliver liquid to the feature while the laser beam acts on the substrate, where a region of the feature to which there is an obstruction from the first nozzle is supplied with liquid by the at least a second nozzle from which the obstruction is not present, wherein the first nozzle and the at least a second nozzle comprise at least three nozzles.

18. (Original) The apparatus of claim 17, wherein the first nozzle and the at least a second nozzle are positioned on a single liquid supply structure.

19. (Canceled).

20. (Currently Amended) The apparatus of claim ~~19~~ 17, wherein the at least three nozzle nozzles are oriented to approximate a footprint of the feature.

21. (Currently Amended) An apparatus comprising:
a means for generating optical energy sufficient to remove substrate material to form a feature in a substrate;
a first means for supplying liquid to at least a portion of the feature; and,
a second means for supplying liquid to a region of the feature to which the first means is obstructed; and
means for selectively supplying liquid from the first means, second means, or both the first and second means.

22. (Canceled)

23. (Original) The apparatus of claim 21, wherein the first means comprises a supply means coupled with a nozzle.

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24. (Original) A method comprising:

first configuring a laser machine to deliver liquid along a first liquid supply path to a substrate while laser machining a feature into the substrate to a first feature depth; and,

second configuring the laser machine to deliver liquid along at least one different liquid supply path to the substrate while laser machining the feature into the substrate to a second greater feature depth comprising at least a majority of a thickness of the substrate extending between a first substrate surface and a second substrate surface.

25. (Original) The method of claim 24, wherein said first configuring creates a shadow region of the feature and wherein the first liquid supply path is impeded from supplying liquid to the shadow region.

26. (Original) The method of claim 25, wherein said second configuring delivers liquid to the shadow region.

27. (Original) A method comprising:

forming a feature to a first depth in a substrate by supplying a first liquid to essentially an entirety of an area of a first substrate surface defining a first footprint of the feature while moving a laser beam along the first substrate surface; and,

forming the feature to a second greater depth comprising at least a majority of a thickness of the substrate by supplying a second liquid to essentially an entirety of an area of a second substrate surface defining a second footprint of the feature while moving a laser beam along the second substrate surface.

28. (Original) The method of claim 27, wherein the supplying a first liquid and supplying a second liquid comprise supplying a liquid aerosol.

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29. (Original) The method of claim 27, wherein the supplying a first liquid comprise supplying the first liquid along at least a first liquid supply path and supplying a second liquid comprises supplying the second liquid along at least a second liquid supply path that is oriented to supply liquid to a region of the feature that the first liquid supply path does not reach.

30. (Original) A method of laser micromachining a substrate comprising:
forming a feature into a substrate, at least in part, by directing a laser beam at the substrate; and,
during at least a portion of said forming, supplying liquid to at least a first region of the feature along a first liquid supply path and supplying liquid to at least a second different region of the feature along at least a second liquid supply path, wherein said acts of supplying liquid allow the feature to be formed at a faster rate than would be achieved in the absence of the liquid.

31. (Original) The method of claim 30, wherein the supplying liquid to a first region and supplying liquid to a second region reduces an incidence of redeposition of laser machining debris proximate the feature.

32. (Original) The method of claim 30, wherein the supplying liquid to a first region and supplying liquid to a second region reduce an incidence of redeposition of laser machining debris proximate the feature which allows the feature to more closely approximate a desired feature profile.

33. (Original) A method comprising:
forming a feature into a substrate, at least in part, by directing a laser beam at the substrate to remove substrate material at a laser interaction zone; and,
during at least a first duration of said directing, first supplying liquid to the laser interaction zone from a first nozzle, and during at least a second different duration of said directing, second supplying liquid to the laser interaction zone from at least a second different nozzle.

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34. (Original) The method of claim 33, wherein the second supplying comprises supplying the liquid when the laser interaction zone is in a region of the feature which is obstructed from the first nozzle.

35. (Original) The method of claim 33, wherein the first supplying comprises supplying the liquid when the laser interaction zone is in a region of the feature which is obstructed from the second nozzle.

36. (Original) The method of claim 33 further comprising supplying liquid from both the first nozzle and the second nozzle during a third duration.

37. (Original) A method comprising:
forming a feature into a substrate, at least in part, by directing a laser beam at the substrate to remove substrate material at a laser interaction zone; and,
during at least a first duration of said directing, selectively controlling a delivery of liquid to the laser interaction zone along at least two different liquid supply paths.

38. (Original) The method of claim 37, wherein said selectively controlling comprises delivering liquid along a first liquid supply path and not delivering liquid along a second supply path when the laser interaction zone is in a first region of the feature.

39. (Original) The method of claim 38, wherein said selectively controlling comprises delivering liquid along the second liquid supply path and not delivering liquid along the first liquid supply path when the laser interaction zone is in a second region of the feature that is obstructed from being directly supplied by the first path.

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